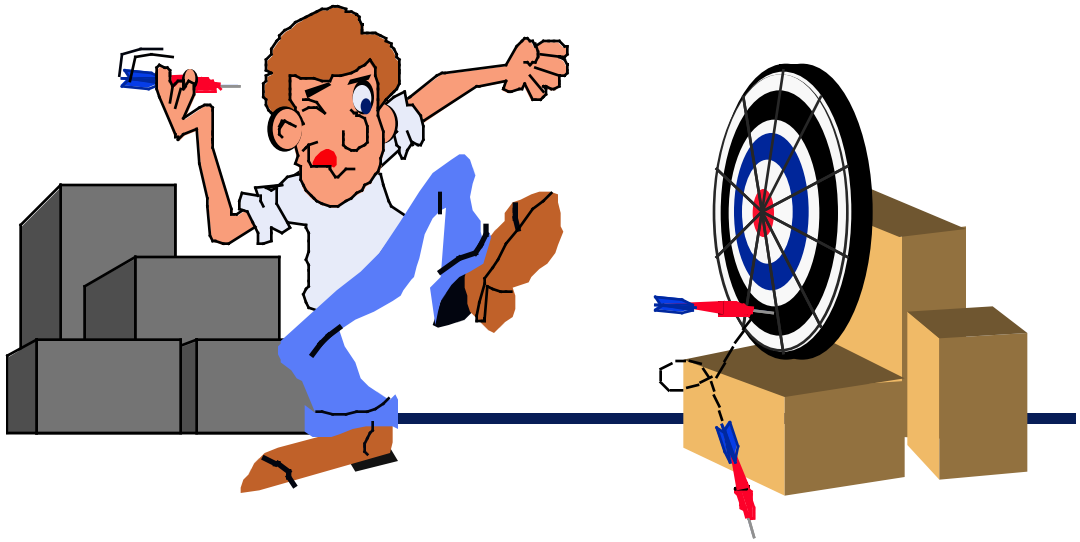
VV&A PLANNING

Credible Models for Credible Analysis . . .



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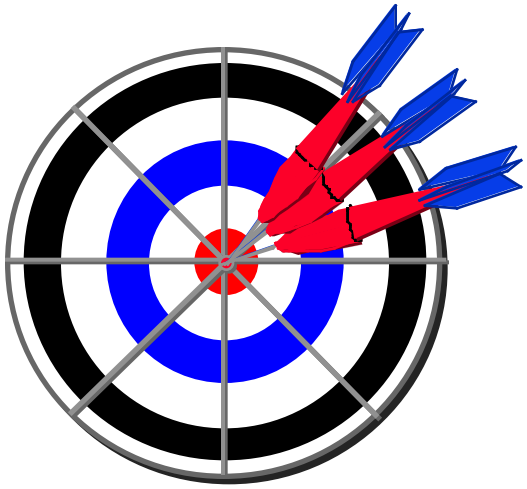
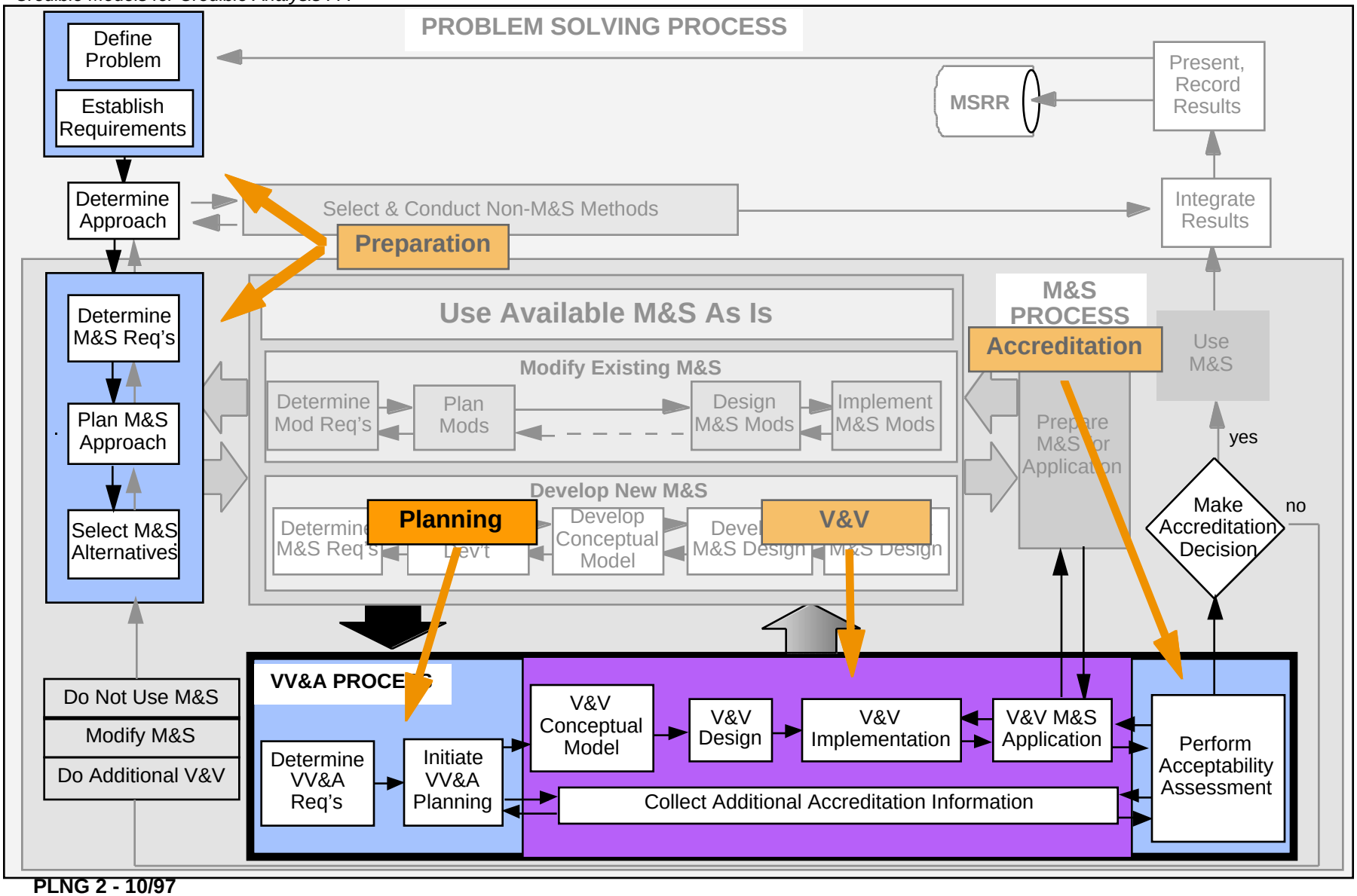


PLANNING V&V TO SUPPORT ACCREDITATION

SECTION TOPICS

Credible Models for Credible Analysis . . .



PLANNING OVERVIEW

Credible Models for Credible Analysis . . .

- **TWO MAJOR TASKS**
  - > **Establish requirements for ACCREDITATION**
    - » Formal Review and Approval Requirements
    - » ESSENTIAL VV&A Data Requirements
  - > **Plan the execution of VV&A tasks**

- **HOW DO YOU CONTROL VV&A COSTS?***
  - > **Focus on M&S functions related to critical problem elements**
  - > **Focus on application-specific requirements for credibility**
  - > **Focus on using VV&A information that already exists**

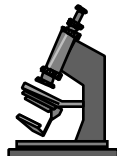
- **WHAT IF YOU NEED MORE VV&A DATA?**
  - > **Evaluate risks associated with data shortfalls**
  - > **Do they justify the expenditure necessary to get the data?**

*** i.e, V&V costs associated with M&S accreditation.**
(Not including S/W V&V or IV&V costs during development.)

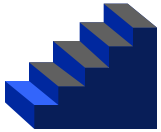
APPROACH TO COST CONTROL

Credible Models for Credible Analysis . . .

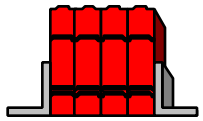
- **FOCUS ON CRITICAL PROBLEM ELEMENTS**
  - > Typically related to important M&S functions
  - > Identified through sensitivity analyses and/or expert judgment



- **ESTABLISH LEVEL OF CREDIBILITY NEEDED**
  - > Based on problem impacts and importance
  - > Using risk analysis techniques (description follows)



- **CAPITALIZE ON EXISTING VV&A DATA**
  - > Facilitated by use of common VV&A data elements and reporting structure (Described in Section 4)



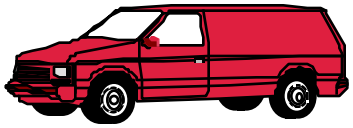
DMSO RPG DESCRIBES 76 POSSIBLE V&V TECHNIQUES
YOU CAN ID THE RIGHT TASKS BY FOCUSING ON CRITICAL REQUIREMENTS

IDENTIFYING CRITICAL PROBLEM ELEMENTS

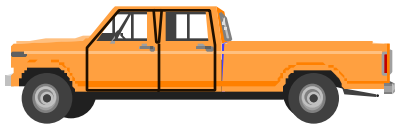
Credible Models for Credible Analysis . . .

A PRACTICAL PROBLEM: SELECTION OF A NEW VEHICLE

HYPOTHETICAL REQUIREMENTS, THRESHOLDS ( ), AND METRICS



- **PASSENGER COMFORT (6 PASSENGERS)** ⌦
  - > Legroom
  - > Compartment width
- **1-TON TOWING CAPABILITY**
  - > Size of engine
  - > Rear axle ratio
- **REASONABLE MONTHLY PAYMENTS**
  - > Selling price
  - > Interest rate
  - > Period of loan
- **LOW OPERATING COSTS** ⌦
  - > Mileage (Better than 20 mpg)
  - > Low frequency of repairs
  - > Cost of typical repair action
  - > Impervious to rust



⌦ Indicates a critical requirement

( ) Indicates a threshold

WHAT ARE THE CRITICAL METRICS*?

Credible Models for Credible Analysis . . .

THOSE WITH A HIGH IMPACT ON CRITICAL REQUIREMENTS

REQUIREMENT & METRIC	IMPACT OF METRIC ON REQUIREMENT	LEVEL OF IMPORTANCE
⊠ COMFORTABLE 6-PASSENGER CAPABILITY		
Legroom	Moderate	Moderate
Compartment width	High	High
· 1-TON TOWING CAPABILITY		
Size of engine	High	Moderate
Rear axle ratio	Moderate	Low
· REASONABLE MONTHLY COSTS		
Selling price	High	Moderate
Interest rate	Low	Low
Period of loan	Moderate	Low
⊠ LOW OPERATING COSTS		
Better than 20 mpg	High	High
Low frequency of repairs	Moderate	Moderate
Low average cost of each repair	Low	Low
Impervious to rust	Low	Low

* Can be related to the output of a model (or function) or other data source

\# Can be determined through sensitivity analysis or judgement

ESTABLISHING CREDIBILITY REQUIREMENTS

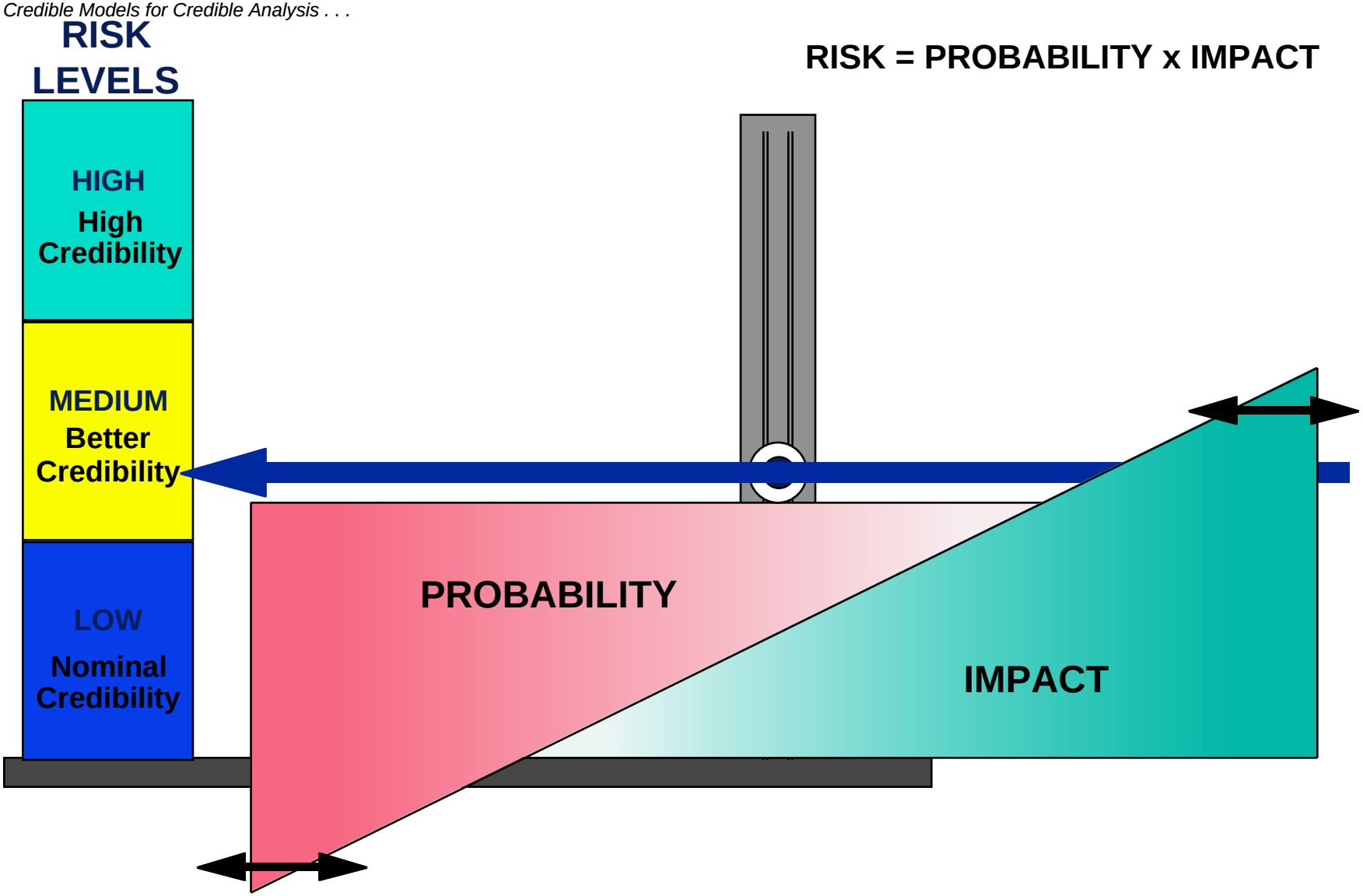
Credible Models for Credible Analysis . . .

- **DEPENDS ON:**
  - > **OUTCOME RISKS AND BENEFITS**
    - » High risk/benefit = High credibility
    - » Medium risk/benefit = Better credibility
    - » Low risk/benefit = Nominal credibility
  - > **CORROBORATING INFORMATION**
- **RISKS & BENEFITS ARE SIMILAR**
  - > **RISK CONNOTES BAD CONSEQUENCES**
  - > **BENEFIT CONNOTES GOOD CONSEQUENCES**
  - > **ONE CAN OFTEN BE EXPRESSED AS THE OTHER**
    - » Risk - The chance of being “shot down”
    - » Benefit - The chance of “surviving”
- **RISKS & BENEFITS CAN BE QUANTIFIED USING SIMILAR TECHNIQUES**

QUANTIFYING RISK

JASA

Credible Models for Credible Analysis . . .



A SIMPLE EXAMPLE

- **VEHICLE PURCHASE PROBLEM**
  - > **RISKS:**
    - » Mother-in-law may be uncomfortable riding with your family of 5 (because she is “horizontally challenged”)
    - » You can’t get your boat to your favorite mountain lake in reasonable time
    - » Operating costs could exceed budget

- **PROCESS ELEMENTS**
  - > **IDENTIFYING EACH RISK (DONE ABOVE)**
  - > **QUANTIFYING PROBABILITY**
  - > **QUANTIFYING IMPACT**
  - > **QUANTIFYING RISK BASED ON PROBABILITY AND IMPACT LEVELS**

QUANTIFYING RISK PROBABILITY

PROBABILITY DESCRIPTION	LIKELIHOOD OF OCCURRENCE OVER LIFETIME OF AN ITEM	LIKELIHOOD OF OCCURRENCE PER NUMBER OF ITEMS**
FREQUENT	Likely to Occur Frequently	Widely Experienced
PROBABLE	Will Occur Several Times in Life of Item	Will Occur Frequently
OCCASIONAL	Likely to Occur Some Time in Life of Item	Will Occur Several Times
REMOTE	Unlikely but Possible to Occur in Life of Item	Unlikely but can Reasonably be Expected to Occur
IMPROBABLE	So Unlikely, it can be Assumed Occurrence May Not be Experienced	Unlikely to Occur but Possible

**The number of Items should be specified

OUR EXAMPLE...

- **RISK 1: UNCOMFORTABLE MOTHER-IN-LAW**
  - > **SHE LIVES NEXT DOOR: *FREQUENT***
  - > **IF SHE LIVED IN ANOTHER STATE: *REMOTE***
- **RISK 2: INABILITY TO GET TO LAKE**
  - > **YOU GO FISHING EVERY OTHER WEEK: *FREQUENT***
- **RISK 3: BUSTING YOUR BUDGET**
  - > **DIRECTLY RELATED TO THE DEGREE THAT THE OPERATING COSTS EXCEED THRESHOLD**
  - > **THE GREATER THE COSTS THE HIGHER THE PROBABILITY**

QUANTIFYING RISK IMPACT

IMPACT CATEGORIES	IMPACT LEVELS			
	CATASTROPHIC	CRITICAL	MARGINAL	NEGLIGIBLE
PERSONNEL SAFETY	Death	Severe Injury	Minor Injury	Less than Minor Injury
EQUIPMENT SAFETY	Major Equip Loss; Broad Scale Major Damage	Small Scale Major Damage	Broad Scale Minor Damage	Small Scale Minor Damage
ENVIRONMENT DAMAGE	Severe (Chernobyl)	Major (Love Canal)	Minor	Some Trivial
OCCUPATIONAL ILLNESS	Severe & Broad Scale	Severe or Broad Scale	Minor & Small Scale	Minor or Small Scale
COST	Loss of Program Funds; 100% Cost Growth	Funds Reduction; 50% to 100% Cost Growth	20% to 50% Cost Growth	< 20% Cost Growth
SCHEDULE	Slip Reduces DoD Capabilities	Slip Causes Cost Impact	Slip Causes Internal Turmoil	Republish Schedules
POLITICAL	Nat'l or Internat'l (Watergate)	Significant (Tailhook '91)	Embarrassment ($200 Hammer)	Local
OPERATIONAL	Widespread Add'l Combat Deaths	Limited Add'l Combat Deaths	Moderate Add'l Casualties	Minimal Add'l Casualties

OUR EXAMPLE...

(TAILORED CRITERIA)

IMPACT CATEGORIES	IMPACT LEVELS			
	CATASTROPHIC	CRITICAL	MARGINAL	NEGLIGIBLE
LIFESTYLE IMPACTS	Total Change	Major Adjustments	Minor Adjustments	Minor Annoyance

- **RISK 1: UNCOMFORTABLE MOTHER-IN-LAW**
  - > **SHE HABITUALLY BELITTLES YOU IN FRONT OF YOUR FAMILY AT EVERY OPPORTUNITY: *CRITICAL***
- **RISK 2: INABILITY TO GET TO LAKE**
  - > **YOU HAVE A SYMPATHETIC BUDDY WITH A BOAT: *MARGINAL***
- **RISK 3 BUSTING YOUR BUDGET**
  - > **DIRECTLY RELATED TO THE DEGREE THAT THE OPERATING COSTS EXCEED BUDGET THRESHOLD: *MARGINAL* TO *CRITICAL***

QUANTIFYING LEVEL OF RISK

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Credible Models for Credible Analysis . . .

RISKS

PROBABILITY	LEVEL OF IMPACT			
	CATASTROPHIC	CRITICAL	MARGINAL	NEGLIGIBLE
FREQUENT	High	High	Medium	Low
PROBABLE	High	High	Medium	Low
OCCASIONAL	Medium	Medium	Medium	Low
REMOTE	Medium	Medium	Low	Low
IMPOSSIBLE	Medium	Low	Low	Low

- **RISK 1: UNCOMFORTABLE MOTHER-IN-LAW**
  - > PROBABILITY: *FREQUENT*
  - > IMPACT: *CRITICAL*
  - > RISK: *HIGH*
- **RISK 2: INABILITY TO GET TO LAKE**
  - > PROBABILITY: *FREQUENT*
  - > IMPACT: *MARGINAL*
  - > RISK: *MEDIUM*
- **RISK 3: BUSTING YOUR BUDGET**
  - > PROBABILITY: *REMOTE* TO *PROBABLE*
  - > IMPACT: *MARGINAL* TO *CRITICAL*
  - > RISK: *MEDIUM (avg)*

RISK LEVEL VALUES ARE:
- Subjective
- Consistent with MIL-STD-882C
- Tailorable to each problem

CONCLUSIONS
- Metrics affecting comfort need high credibility
- Metrics affecting towing capability and costs need moderate credibility

WHAT DOES IT MEAN?

Credible Models for Credible Analysis . . .

Problem Metric	Level of Importance	Level of Risk	Required Credibility	Typical Data Source	Current Credibility Level	More Credibility Needed
Legroom	Moderate	High	Moderate	Manuf. Data	High	
Compartment width	High	High	High	Manuf. Data	High	
Engine size	Moderate	Moderate	Moderate	Manuf. Data	High	
Rear axle ratio	Low	Moderate	Low	Manuf. Data or Magazine Info	Low to Moderate	
Selling price	Moderate	Moderate	Moderate	Dealer	High	
Interest rate	Low	Moderate	Low	Dealer or Bank	High	
Period of loan	Low	Moderate	Low	Dealer of Bank	High	
Better than 20 mpg	High	Moderate	Moderate	Manuf. Data or Magazine Info	Low	X
Low freq of repairs	Moderate	Moderate	Moderate	Magazine Review	Moderate	
Low cost of each repair	Low	Moderate	Low	Magazine Review	Low	
Impervious to rust	Low	Moderate	Low	Manuf. Data	Moderate	

Additional confidence (e.g., more V&V or other data) is needed wherever the required credibility exceeds the current credibility level.

CAPITALIZE ON EXISTING VV&A DATA

Credible Models for Credible Analysis . . .

- **EXTRACT USEFUL DATA FROM SOFTWARE V&V RESULTS**
  - > **UNDERSTAND WHAT DATA ARE USEFUL**
  - > **REVIEW RESULTS AND COLLECT DATA**
  - > **PREPARE ACCREDITATION SUPPORT PACKAGES**

  More on this in next section

- **AVOID REPEATING PREVIOUS WORK**
  - > **PRACTICE EFFECTIVE CONFIGURATION MANAGEMENT**
    - » So VV&A data can be related to particular M&S version
  - > **ESTABLISH AND USE A REPOSITORY OF VV&A DATA**
    - » Presented in reasily usable formats
    - » Indexed by useful search categories
  - > **UPDATE THE DATA REPOSITORY WITH NEW RESULTS**

  More on this in next section

- **STATUS**
  - > **WE'RE NOT THERE YET**
  - > **VARIOUS PARTIAL APPROACHES**
    - » MSRR and JASA are principal current sources
    - » Local repositories may be useful

WHAT'S NEXT?

- **VV&A PLANNING IS FOCUSED ON:**
  - > IMPORTANT PROBLEM ELEMENTS
  - > MEETING CRITICAL CREDIBILITY REQUIREMENTS
  - > USING EXISTING DATA WHEREVER POSSIBLE
- **RESULT SHOULD BE A LIST OF UNFILLED VV&A DATA REQUIREMENTS**
- **DOES THIS LIST NECESSARILY EQUATE TO A VV&A TASK LIST?**

NO!

- **EVALUATE THE RISKS OF NOT HAVING THE DATA OR USING WORKAROUNDS**
- **ASSESS WHETHER THESE RISKS JUSTIFY THE COST OF DOING THE V&V TO GET THE DATA**

RISK ASSESSMENT QUESTIONS

FOR EACH MISSING OR INSUFFICIENT DATA ELEMENT

- **WHAT M&S OUTPUTS MIGHT BE IMPACTED?**
  - > How will they be impacted?
  - > What is the likelihood that the impacts will occur?

- **HOW MIGHT POTENTIAL DECISIONS BE IMPACTED?**
  - > Could M&S output errors cause sufficient errors in key problem metrics to cross threshold values?

- **ARE THERE ANY WORKAROUNDS?**
  - > What techniques might exist to limit error magnitudes or impacts?
  - > What techniques might be used to reduce the likelihood of errors?

- **ARE EFFECTS OF POSSIBLE ERRORS TOLERABLE?**
  - > What is the cost of possible decision errors?
  - > Do these costs exceed cost of getting VV&A data?

EXPERIENCE-BASED LESSONS

- **GOOD PLANNING NOW SAVES $$$ LATER**

- **PLANNING IS A GOV'T FUNCTION**
  - > **A contractor can document a plan...**
  - > **But can't do your planning**

- **CRITICAL PLANNING STEP: IDENTIFYING WHAT'S NEEDED**

- **KEYS TO GOOD PLANNING**
  - > **Decision-maker involvement**
  - > **Commitment to serious reflection & analysis by government managers**

- **GOOD PLANNING MAY BE COMMON SENSE...**
  - > **BUT IT'S NOT COMMON PRACTICE!**

SECTION SUMMARY

GOOD PLANNING IS THE MAJOR MEANS OF SAVING VV&A $$$

- **FOCUS ON CRITICAL PROBLEM ELEMENTS, M&S FUNCTIONS**
- **FOCUS ON CRITICAL REQUIREMENTS FOR CREDIBILITY**
- **FOCUS ON USING EXISTING VV&A DATA**
- **EVALUATE RISKS OF NOT HAVING THE REQUIRED DATA**

THE GOAL OF THIS PLANNING APPROACH IS TO ENSURE THAT ALL ACCREDITATION REQUIREMENTS ARE MET.

IT DOES NOT NECESSARILY ENSURE SATISFACTION OF ALL S/W V&V REQUIREMENTS

SUPPLEMENTARY CHARTS
(PLANNING)

REVIEW & APPROVAL REQUIREMENTS

Credible Models for Credible Analysis . . .

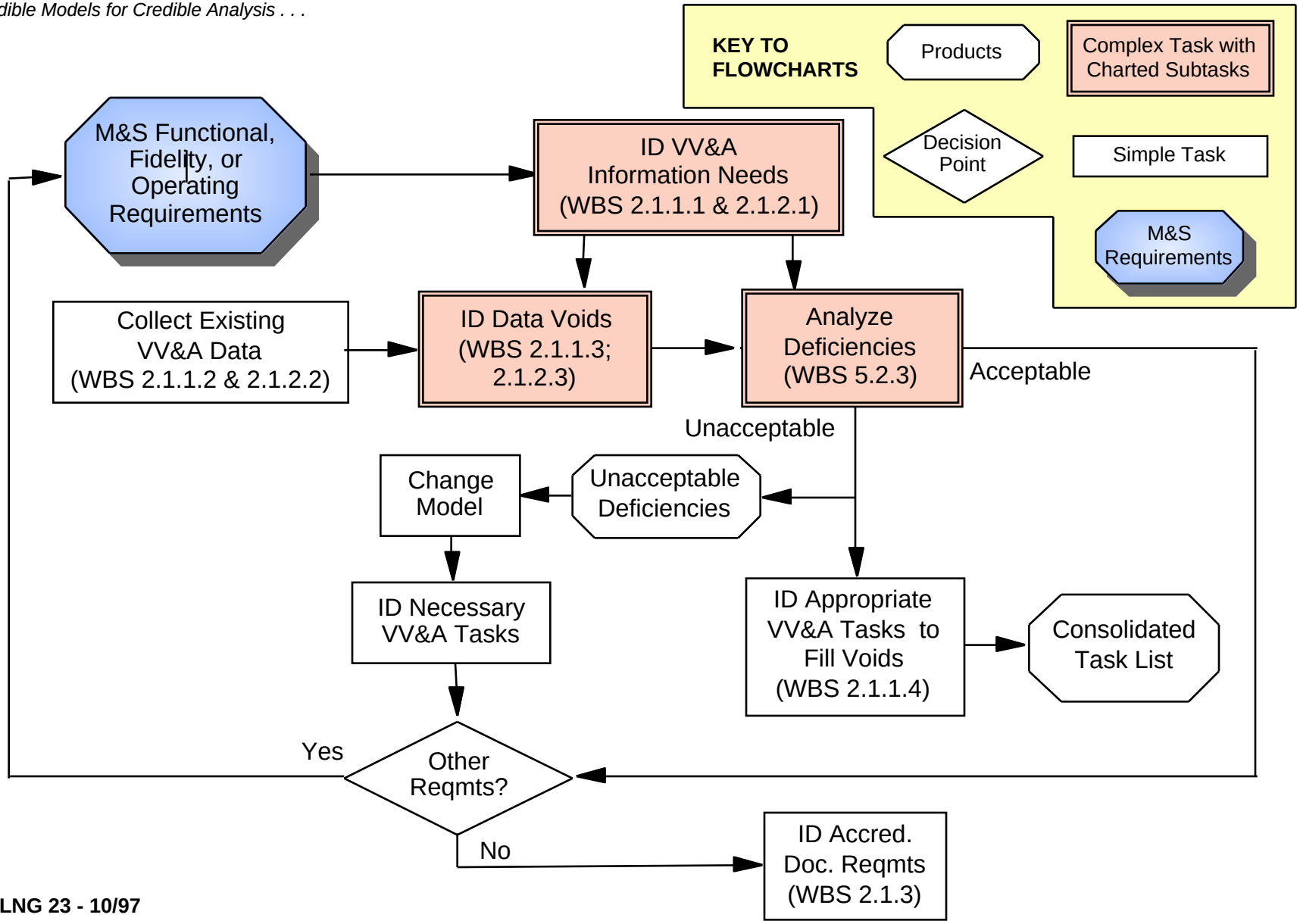
TYPICAL APPROACH TO IDENTIFYING REVIEW & APPROVAL REQUIREMENTS

- **WHAT REVIEWS ARE REQUIRED BY POLICY?**
  - > DETERMINED BY REVIEWING SERVICE & ORGANIZATIONAL INSTRUCTIONS
- **WHO IS THE ACCREDITATION AUTHORITY?**
  - > SPECIFIED BY APPLICABLE SERVICE INSTRUCTION
- **WHAT ARE ACCREDITATION AUTHORITY REQUIREMENTS?**
  - > REGARDING SPECIAL REVIEWS OR INTERMEDIATE APPROVALS
  - > TYPICALLY IDENTIFIED THROUGH DIRECT INTERACTION WITH AUTHORITY

DETERMINATION OF REVIEW & APPROVAL REQUIREMENTS IS A SIMPLE PROCESS FAMILIAR TO MOST PROGRAM MANAGEMENT PERSONNEL

JASA DETERMINING VV&A DATA REQUIREMENTS

Credible Models for Credible Analysis . . .



INFORMATION USAGE

Credible Models for Credible Analysis . . .

THE BASIS FOR IDENTIFYING INFORMATION REQUIREMENTS

FOR COMPARISON WITH OPERATING REQUIREMENTS

Non-V&V Information

- Model Documentation
- Model H/W and S/W Compatibility Features
- User Support Services
- Configuration Management Process and Effects

FOR COMPARISON WITH FUNCTIONAL REQUIREMENTS

Non-V&V Information

- Model Documentation
- VV&A Status and Usage History
- Output Data Parameters
- Configuration Management Process and Effects

V&V Information

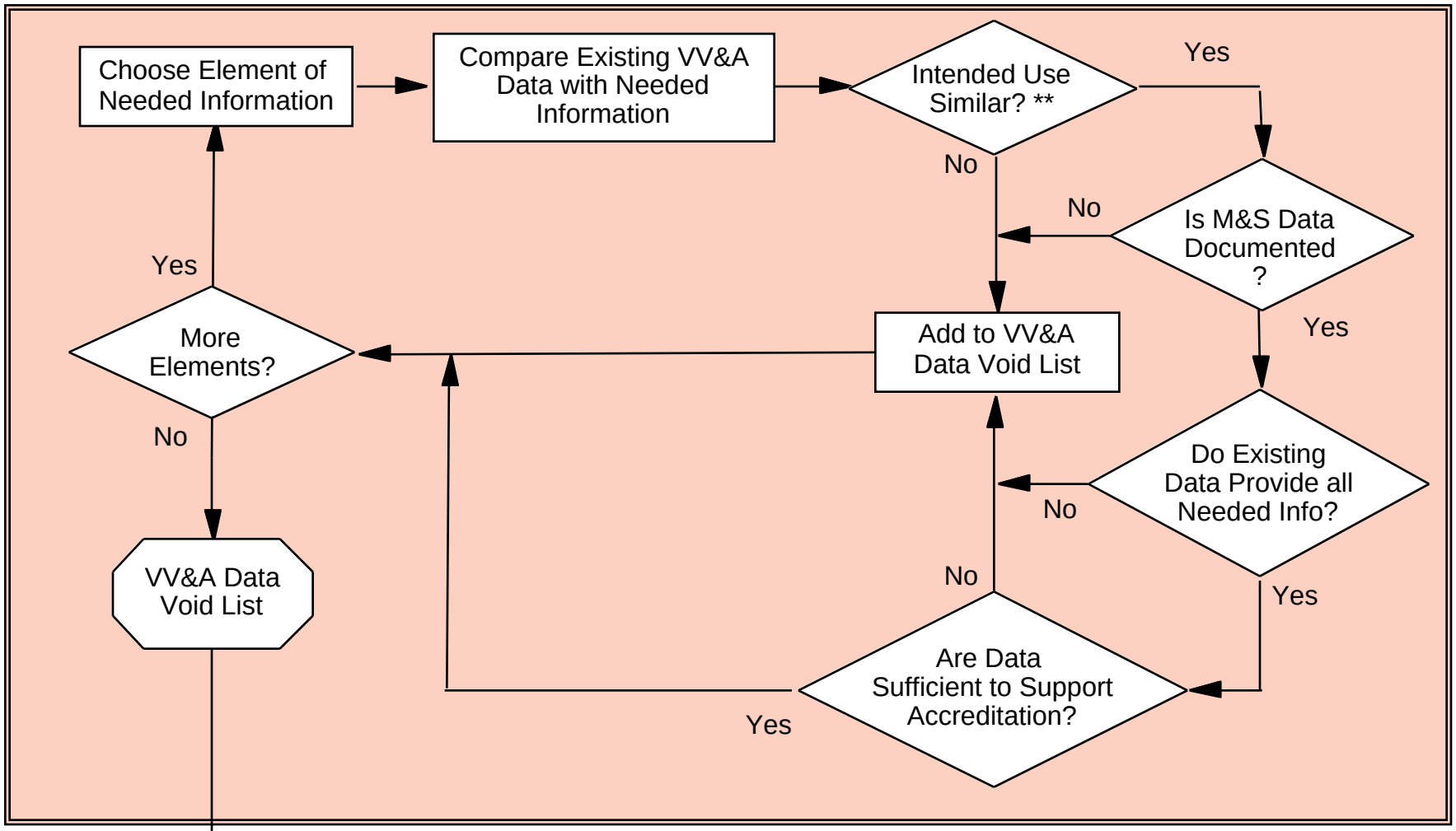
FOR COMPARISON WITH FIDELITY REQUIREMENTS

V&V Information

THE TYPE AND DEPTH OF V&V DATA NEEDED IS DICTATED IN PART BY CREDIBILITY REQUIREMENTS

ID VV&A DATA VOIDS

Credible Models for Credible Analysis . . .



** Applies only to Design Logic Checks, Face Validation, and Benchmark Results

DEFICIENCY ANALYSIS STEPS

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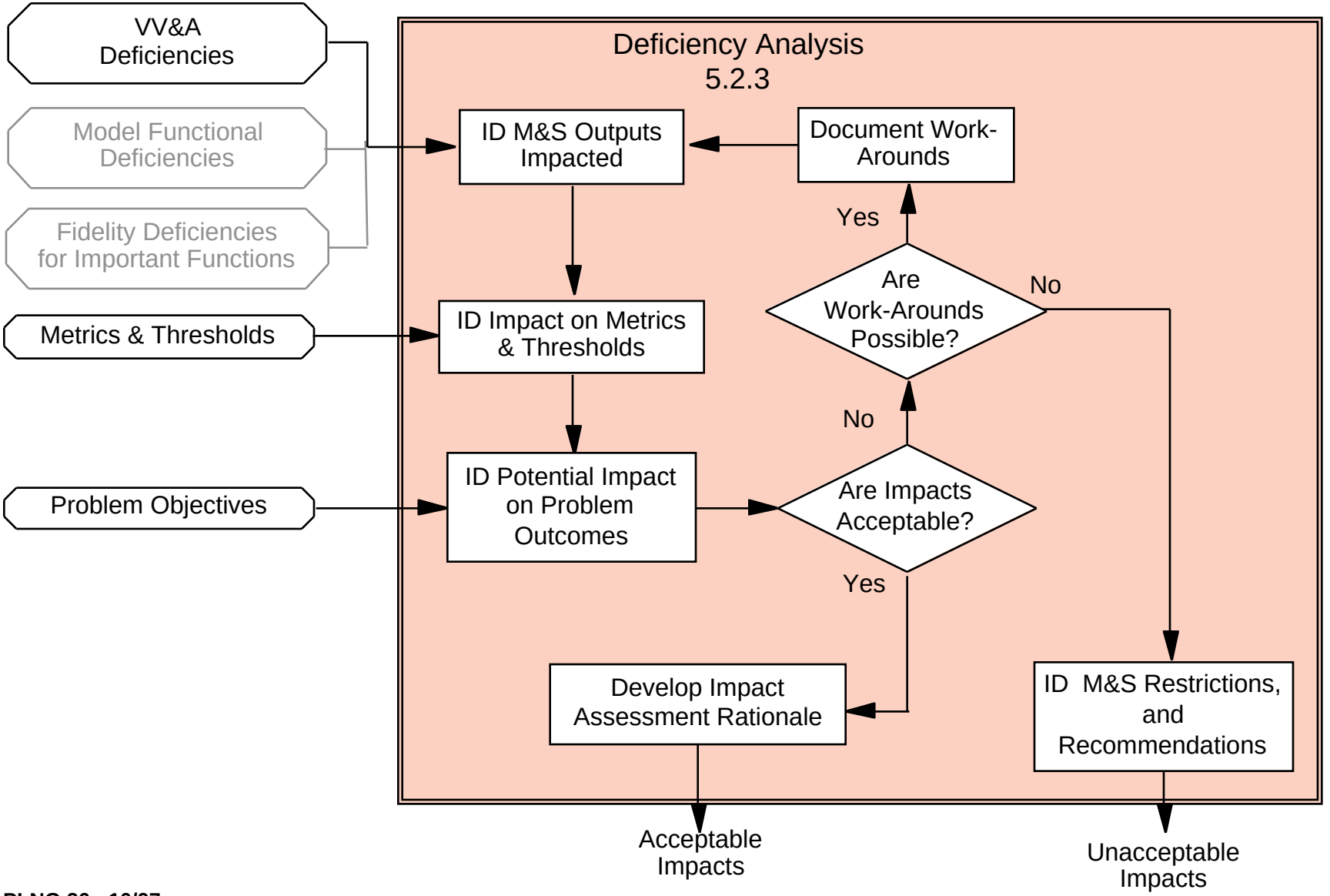
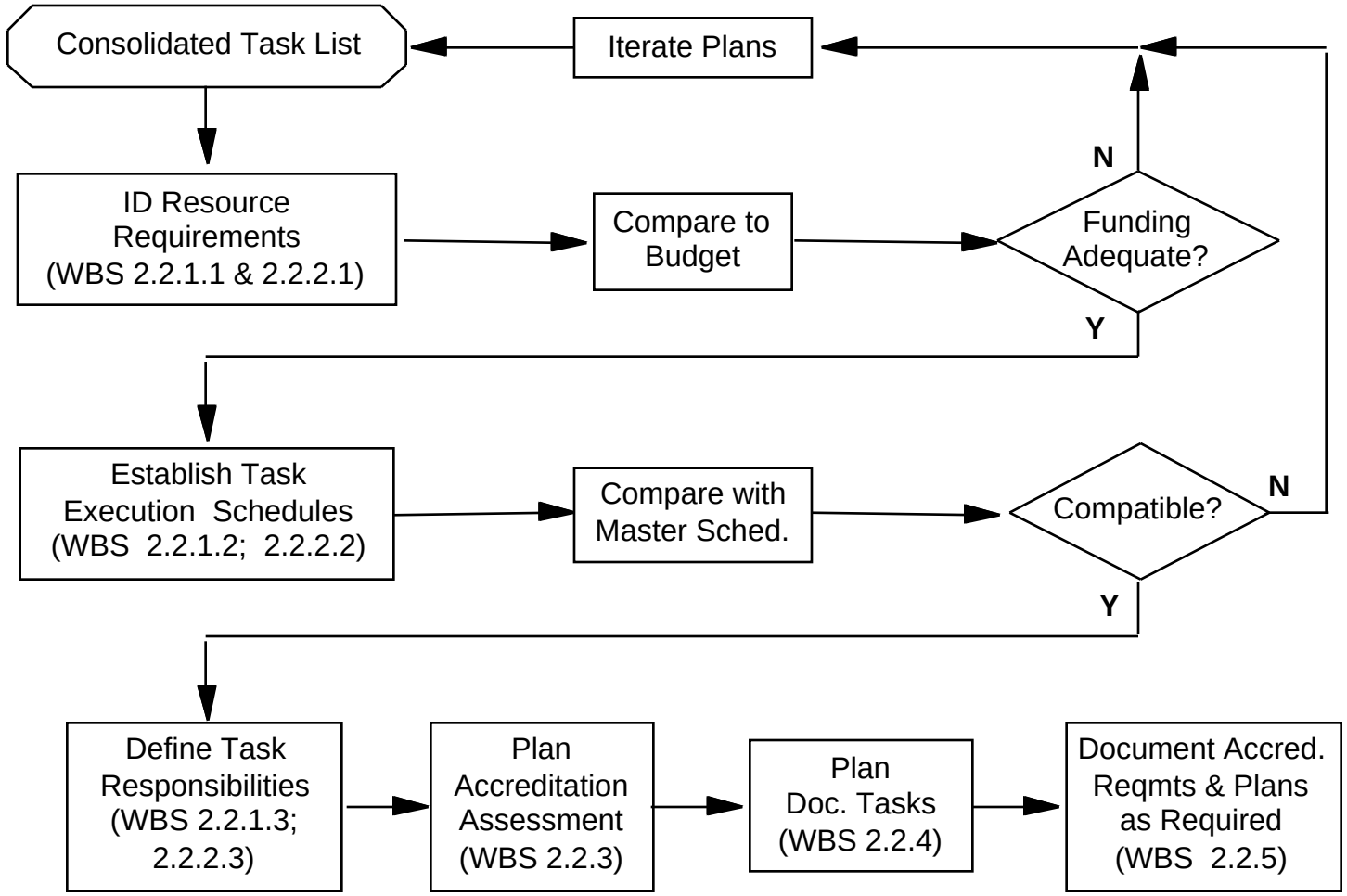
Credible Models for Credible Analysis . . .



PLAN VV&A TASKS

Credible Models for Credible Analysis . . .



ESTABLISHING VV&A PLANS

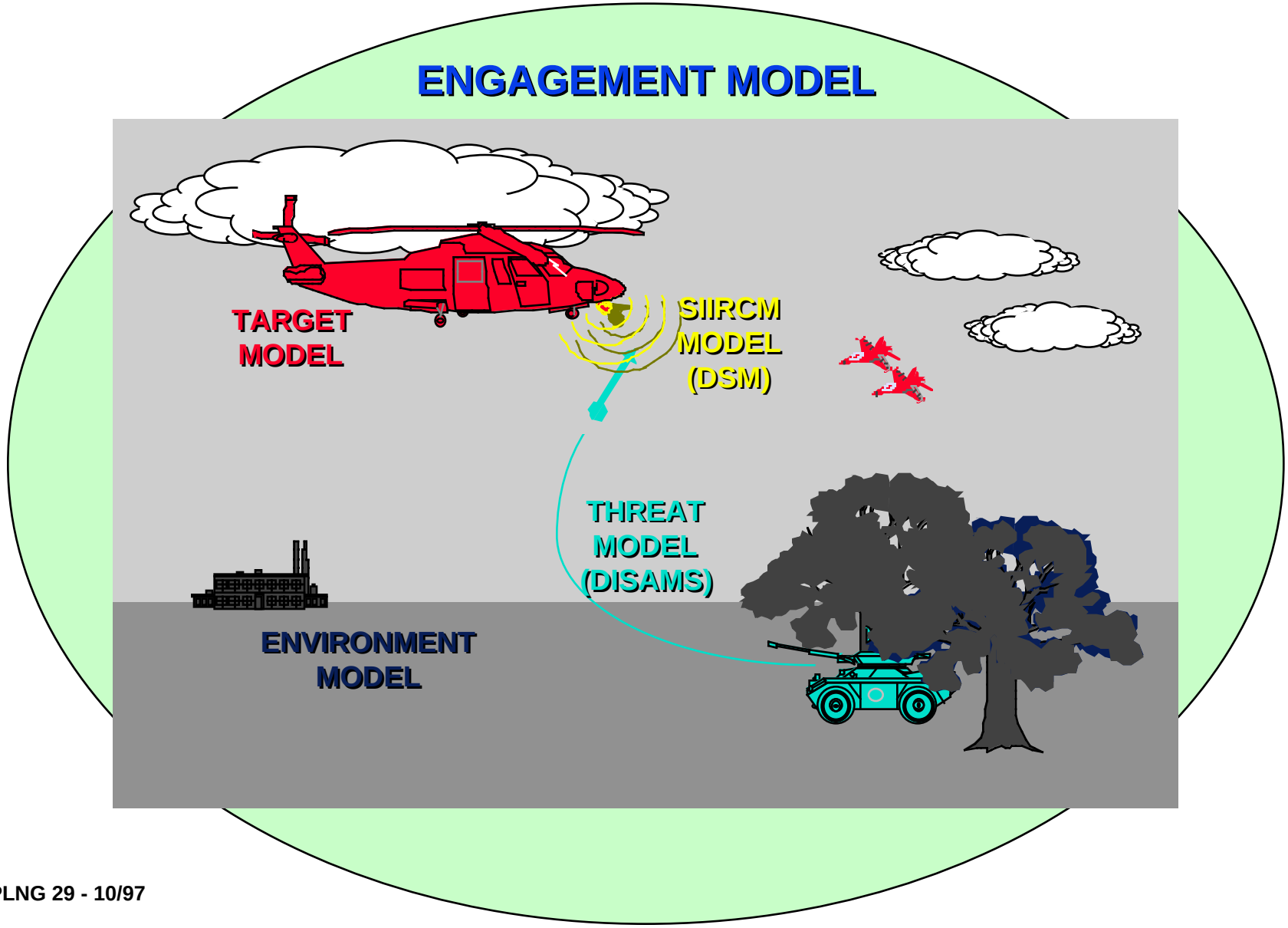
Credible Models for Credible Analysis . . .

- **V&V TASK PLANNING**
  - > **ARE SUFFICIENT FUNDS AVAILABLE TO PERFORM CRITICAL TASKS?**
  - > **CAN TASKS BE ACCOMPLISHED WITHIN MASTER SCHEDULE TIMEFRAME?**
  - > **ARE PERSONNEL AVAILABLE TO PERFORM TASKS?**
    - » Who? Where? Mechanics of establishing tasks?
  - > **IF ANY ANSWERS ARE "NO"**
    - » Reconsider critical needs, or
    - » Develop justification for additional time / resources

- **ACCREDITATION PLANNING**
  - > **WHAT TYPE OF ASSESSMENT IS NEEDED?**
    - » Single person or expert panel?
  - > **WHO? WHEN? HOW?**
    - » Assessment planning to be addressed in section 5

ID VV&A INFORMATION NEEDS - SIIRCM EXAMPLE

Credible Models for Credible Analysis . . .



T&E CREDIBILITY ANALYSIS

M&S APPLICATION: TEST DATA EXTRAPOLATION

- **RISK 1 - SIIRCM PERFORMANCE OVERESTIMATED**
  - > **IMPACT: *CRITICAL***
    - » Unnecessary combat losses will occur
  - > **PROBABILITY: *OCCASIONAL***
    - » Frequency of combat losses likely to increase

- **RISK 2 - SIIRCM PERFORMANCE UNDERESTIMATED**
  - > **IMPACT: *MARGINAL***
    - » Cost of system too high - Possible redesign if M&S data shows performance below threshold; no impact if above threshold
  - > **PROBABILITY: *OCCASIONAL***
    - » Likely to occur sometime in life of SIIRCM

T&E REQUIRED CREDIBILITY LEVELS

JASA

Credible Models for Credible Analysis . . .

RISK 1

FREQUENCY	LEVEL OF IMPACT			
	CATASTROPHIC	CRITICAL	MARGINAL	NEGLIGIBLE
FREQUENT	High	High	Medium	Low
PROBABLE	High	High	Medium	Low
OCCASIONAL	Medium	Medium	Medium	Low
REMOTE	Medium	Medium	Low	Low
IMPOSSIBLE	Medium	Low	Low	Low

RISK 2

FREQUENCY	LEVEL OF IMPACT			
	CATASTROPHIC	CRITICAL	MARGINAL	NEGLIGIBLE
FREQUENT	High	High	Medium	Low
PROBABLE	High	High	Medium	Low
OCCASIONAL	Medium	Medium	Medium	Low
REMOTE	Medium	Medium	Low	Low
IMPOSSIBLE	Medium	Low	Low	Low

Values for credibility requirements entries are subjective, but consistent with the guidance of MIL-STD-882C

V&V FOCUSING GUIDE

Credible Models for Credible Analysis . . .

V&V FOCUS	IMPACT LEVELS			
	CATASTROPHIC/ REVOLUTIONARY	CRITICAL/ SIGNIFICANT	MARGINAL	NEGLIGIBLE
COEA	M	M	M	M
SYSTEM DESIGN	M&F	F	F	F
TEST PLANNING	M	M	M	M
TEST SAFETY ASSESSMENT	M&F	M&F	F	F
T&E EXTRAPOLATION	M&F	M&F	M	M

CHART ENTRIES BASED ON EXPERT JUDGMENT ABOUT LEVEL OF DETAIL REQUIRED FOR THE LISTED APPLICATIONS

- **CREDIBILITY REQ'S SUMMARY**
  - > **CREDIBILITY LEVEL:** ***Medium***
  - > **FOCUS:** ***Model and Function***

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V&V TECHNIQUE SELECTION GUIDE

Credible Models for Credible Analysis . . .

V&V MENU	MODEL LEVEL			FUNCTION LEVEL		
	High	Medium	Nominal	High	Medium	Nominal
Baseline Definition	X	X	X	X	X	X
Determine C/M Attributes	X	X	X	X	X	X
Assess M&S Documentation	X	X	X	X	X	X
Est. VV&A and Usage History	X	X	X	X	X	X
S/W Quality Ass'mt	X			X		
ID Assumptions & Limitations	X	X	X	X	X	X
Produce Design Documentation	X	X		X	X	
Perform Logical Ver.	X	X		X	X	
Detailed Code Ver.	X			X		
Sensitivity Analysis - Model Level	X	X		X	X	
Sensitivity Analysis - Function Level				X	X	
Face Validation		X			X	
Model Level Results Validation	X			X		
Function Level Results Validation				X		